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ASSESSING THE IMPACT OF VARIOUS PEST MANAGEMENT STRATEGIES ON *AMRASCA BIGUTTULA BIGUTTULA* ISHIDA, (CICADELLIDAE: HOMOPTERA) AND FRUIT INFESTATION OF OKRA (*ABELMOSCHUS ESCULENTUS* L.)

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ABSTRACT

This study was conducted to evaluate the impact of seven treatments (T_1: Flonicamid @ 40g/acre, T_2: Sanitation (hoeing and weeding), T_3: *Crysoperla carnae* @ 1L/plant @ month interval, T_4: Neem seed oil @ 5%, T_5: Flonicamid and Sanitation, T_6 : Flonicamid and Neem seed oil, T_7 : Flonicamid and *C. carnae*) on population density of leafhopper and fruit infestation of okra under field conditions. The results reveal that integrated application of Flonicamid and neem seed oil demonstrated least infestation (13.51%) and maximum reduction in infestation (56.82%). Integrated application of Flonicamid and Sanitation resulted in 14.83% infestation and 52.45 % reduction in infestation. The highest infestation (28.36%) and lowest reduction in fruit infestation (9.16%) was recorded where sanitation was applied. While neem seed oil and *Crysoperla carnae,* flonicamid application showed 21.71%, 24.63% and 15.63% fruit infestation; and 30.64 %, 22.42 % and 49.78 % reduction in infestation, respectively. The maximum reduction in leafhopper population was recorded in block where Flonicamid was applied alone (1.29 hoppers/leaf) and Flonicamid and neem seed oil were applied in integration (1.86 hoppers/leaf)) at 5th observation followed by application of Flonicamid and *C. carnae* (1.86 hoppers/leaf) and flonicamid and sanitation (1.99 hoppers/leaf). Application of neem oil and *C. carnae* alone demonstrated 4.16 hoppers/leaf and 4.15 hoppers/leaf, respectively. In conclusion, application of flubendamide alone or in combination with neem-oil, sanitation and *C. carnea* proved better entities for the suppression of leafhoppers and reduction of fruit infestation.

Keywords: Fruit infestation, Field conditions, IPM, Leaf hopper, Okra;

INTRODUCTION

Okra or lady's finger, *Abelmoschus esculentus* L., is an important summer crop in Pakistan with production of 303.16 tons from 232.05 hectares of land per year (Kashif *et al.*, 2008). It contributes 1.2% in total vegetable production in Pakistan. Punjab is one of the leading provinces of Pakistan that contributes 57.3% followed by Baluchistan (15.5%), K.P.K (13.9%) and Sindh (13.3%) (Khokhar, 2014). Okra provides an important source of carbohydrate, protein, fat, vitamins, calcium, potassium and other minerals which are often lacking in the diet of developing countries (Anonymous, 2000). The fruits of okra also have some medicinal value. A mucilaginous preparation from the pod can be used for plasma replacement or blood volume expansion. The okra fruit is considered valuable for control of goiter because of its high iodine contents (Savello *et al.*, 1980).

Okra production is affected by many factors, among these insect pest attack is the major one that causes 69% reduction in okra yield (Mani *et al.*, 2005). About 72 species of insects have been identified that cause infestation in this crops. The most destructive pests of okra include jassid (*Amrasca biguttula biguttula* Ishida), whitefly (*Bemisia tabaci* Gennadius), yellow flower thrips (*Frankiniella sulphurea* Schmutz), aphid (*Aphis gossypii* Glov.), spotted bollworm (*Earius insulana* Bios.) and american bollworm (*Helicoverpa armigera* Hubner).

In Asia, mostly synthetic insecticides are sprayed extensively to control the insect pests as these are fast in action, results are quite acceptable, provide fast control on insect and prevent

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the insect from attack for a certain period. But some insecticide stimulated phenomena like insect resistance, secondary pest outbreak, non-target effects, environmental pollution etc. have prompted the development of alternative control methods. Along with these problems, a great portion of farmer's budget is spent in buying the synthetic chemicals. According to estimation, about 27% of the total insecticides are used only on vegetables and fruits in Pakistan (Dincer and Hussain, 2002). Being a crucial component of Integrated Pest Management (IPM), insecticides are known to reduce the yield loss caused by the insect pests but their injurious use causes negative effects on non-targeted organisms present in environment and are harmful for human health (Soomro *et al.,* 2008).

Therefore, it is a need of time to use suitable, ecofriendly and biodegradable pesticide sources to replace the synthetic insecticides (Javed *et al.* 2015). Some plants possess insecticidal properties and their extracts can be used to eradicate the insect pests. Extracts of Datura, Tumha, Neem, Castor, Hing, Eucalyptus, bitter gourd and garlic are used as botanical extracts (Javed *et al.,* 2015). Amongst them all, neem plant (*Azadirachta indica*) is famous for having insecticidal properties against many insect pests. Oil and water based neem derivatives are a good source for the control of different insects. The most important active ingredients in neem extract is azadirachtin which affects metamorphosis, adult fertility and toxicity and also has anti-feedant and oviposition-deterrent effects (Schmutterer, 1990). But botanical extracts biodegraded soon in the environment that's why these can control insect pest for shorter period of time and increase the cost production too (Schmutterer, 1990). The sole use of any pest management tactic is not a sensible management, rather it depend on integrated pest management (IPM) where cultural chemicals and biological control approaches are focused. An IPM program not only makes the environment less favorable for the insect but also imposes long term effects on pests. Due to this feature, IPM is famous and widely used in in any pest management program but its implementation in Pakistan, is relatively less intensive as the farmers are uneducated and low land holders. Our study focuses on finding the best economical method in controlling the jassid and on lowering the cost production as well. The reason of the need of this study is to evaluate the effectiveness of Flonicamid (Olala) @ 60g/Acre), sanitation (Hewing and Weeding) @ 15 days' interval, *Crysoperla carnea* @ 1 larvae/Plant after 30 days, neem seed oil 5% @ 15 days' interval, Flonicamid and Senitation, Flonicamid and Neem seed oil and Flonicamid and *C. carnae* against okra leafhopper in field conditions..

MATERIALS AND METHODS

The field studied was carried out at experimental area of Entomological Research Institute, Ayub Agricultural Research Institute (AARI), Faisalabad during 2017. The study area was 186.54m above the Sea level (Amjad *et al*., 2000) having hot summer with mean highest temperature of 36.1 °C, mean lowest temperature 24.24 °C and cold winter. During hottest month daily maximum temperature can reach up to 49 °C and daily minimum temperature can be as low as o21.1 °C. Moreover experiment site experiences less than 500 mm average annual rainfall and frequently dust storms (April to May).

Treatments

Eight treatments applied against okra leaf hopper *Amrasca biguttula biguttula* (Ishida) were as follow:

T_1: Flonicamid (Olala) @ 60g/Acre.
T_2: Sanetation (Hewing and Weeding) @ 15 days' interval.
T_3: Crysoperla @ 1 larvae/Plant after 30 days.
T_4: Neem seed oil @ 5% @ 15 days' interval.
T_5: Flonicamid and Sanitation.
T_6: Flonicamid and Neem seed oil.
T_7: Flonicamid and *Crysoperla carnae*.
T_8: Control.

Collection and sowing of seeds

Seeds of Sabz Pari were collected from the Vegetable Research Institute, Ayub Agricultural Research Institute (AARI), Faisalabad. Seeds were sown on 1st April, 2015. The row to row and plant to plant spacing was maintained at 60 cm and 50 cm, respectively.

Preparation of the treatments

Neem oil

A volume of 4 ml neem oil was poured in 1 Litre of water and then 1ml trix was mixed to obtain fine droplet to spray 3m x 2m area.

Crysoperla Carnae

Larvae of *C. carnea* were collected from Entomology Research Institute, Ayub Agriculture Research Institute (AARI) Faisalabad and were released on the plants.

Application of treatments

Evening time is the best time to avoid moisture on the leaves. So, the evening time was selected for spraying. First application was applied after 30 days of germination. Spraying was done by using knapsack sprayer having a pressure of 4.5 kg/cm^2. The spraying was uniformly done with a special care to ensure the complete coverage**.**

Data collection

The data on the number of healthy and infested fruits were recorded from 5 tagged plants at three days interval, in each treatment. The percent infestation of fruit was calculated with the following formula % of fruit infestation = (Number of infested fruits / Total number of fruits) × 100

Similarly, density of leafhopper was counted on ten leaves in each replication after an interval of three days and density of leafhopper per leaf was computed.

RESULTS

This Study was conducted to assess the impact of Sanitation (weeding/ hoeing), spray of neem seed oil (5%), release of *C. carnea* @1 Larva / per plant, spray of Flonicamid (60 gram per acre) individually and in their all possible combinations on population density of leafhopper and fruit infestation in okra under field conditions. The treatments were applied 6 time during 2017 for control okra leafhopper on resistance genotype of okra Sabz pari. The objective of this study was to find out the most effective and economical treatment for the recommendation to the farmers. In 1 three days of observation, the plot where Flonicamid and neem seed oil were collectively applied showed least fruit infestation (13.11%). Integrated application of Flonicamid and sanitation resulted in 16.21% fruit infestation. The highest fruit infestation (26.19%) was recorded in plots where sanitation was applied alone. While other treatments such as Flonicamid, Crysoperla releases and neem seed oil application showed 17.00%, 19.78% and 19.81% fruit infestation, respectively (Table 1). During second observation, integrated application of Flonicamid and neem seed oil showed least infestation (14.14%). The plot where integrated application of Flonicamid and Crysoperla and spray of Flonicamid alone were practiced showed almost similar result with 14.41% and 14.39% fruit infestation respectively. Highest fruit infestation (30.75%) was recorded in plot where sanitation was performed (Table 1). Similarly, during third observation, plot showed least infestation (13.51%) where Flonicamid and neem seed oil were applied and maximum fruit infestation (31.11%) was noticed in plot where sanitation was performed. While other treatment such as Crysoperla releases and spray of Flonicamid showed 25.24% and 15.28% fruit infestation, respectively (Table 1). In fourth and fifth observations similar results were noticed in plot treated with Flonicamid and neem seed oil integratively that demonstrated the least fruit infestation (12.95% and 12.86%). Flonicamid application showed significant result with 16.03% and 15.29% fruit infestation and release of Crysoperla demonstrated 26.83% and 25.15% fruit infestation; while sanitation explained the maximum fruit infestation of 30.43% and 27.50% during fourth and fifth observation respectively (Table 1). During sixth observation, integrated application of Flonicamid and sanitation demonstrated least fruit infestation (13.31%) and surprisingly releases of Crysoperla explained the highest fruit infestation (27.06%). Application of neem seed oil, sanitation and Flonicamid respectively demonstrated 22.33%, 26.19% and 15.81% fruit infestation (Table 1). The maximum reduction in fruit infestation (56.82%) was recorded in those plots which were integratively treated with Flonicamid and neem seed oil followed by plot integratively treated with Flonicamid and sanitation (52.45%) as well as plot treated with Flonicamid alone (49.99%). Integrated application of Flonicamid and Crysoperla resulted in 49.90% reduction in fruit infestation. Application of sanitation measures, Crysoperla and neem seed oil alone demonstrated 9.16%, 22.43% and 30.15% reduction in fruit infestation respectively (Fig.1). It is concluded that combine application of Flonicamid and neem seed oil is most suitable and ecofriendly method to reduce the fruit infestation of okra.

In control treatment, an increasing trend in population of leafhopper was recorded. But in treated blocks, the density of leafhopper decreased upto 5th observation while an increasing trend was observed again on 6th observation. However, maximum reduction in leafhopper population was recorded in block where Flonicamid was applied alone (1.29 hoppers/leaf) and Flonicamid and neem seed oil were applied in integration (1.86 hoppers/leaf)) at 5th observation followed by application of Flonicamid and *C. carnae* (1.86 hoppers/leaf) and flonicamid and sanitation (1.99 hoppers/leaf). Application of neem oil and *C. carnae* alone demonstrated 4.16 hoppers/leaf and 4.15 hoppers/leaf, respectively (Table 2).

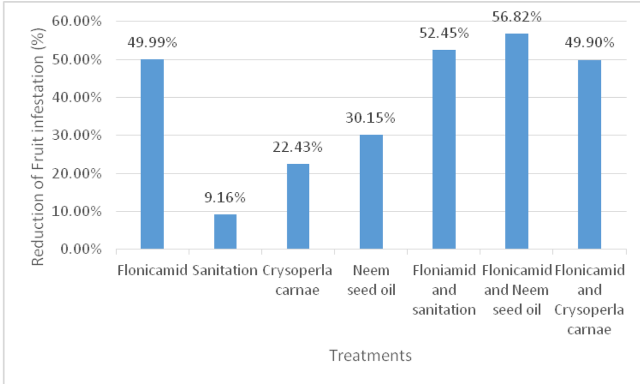

Fig. 1
Reduction in fruit infestation (%) in okra plots implemented with different treatment

DISCUSSION

Integrated application of Flonicamid and neem seed oil proved the most effective resulting in a maximum reduction of fruit infestation (56.82%) and was found at par with those plots where Flonicamid was sprayed along with sanitation (T-5) (52.45% reduction in fruit infestation). Application of Flonicamid alone showed 49.99 percent reduction in fruit infestation where as in combination with the release of Crysoperla (T-7), it show almost same result (49.90 % reduction in fruit infestation). The present findings can partially be compared with those of Raja *et al.* (1998) who reported 49.73, 32.36 and 67.13% reduction in fruit infestation in okra by *Earias* spp. treated with *T. chilonis*, endosulfan and neem seed oil, respectively. The present findings can be compared with those of Aziz *et al.* (2012) who reported 7 % fruit infestation in a chemical treatment. In the present study, the neem seed oil alone showed 13.11% fruit infestation in okra due to *Earias* spp. These findings can be compared with those of Rahman *et al.* (2013), who reported that neem seed oil showed 10.05-14.98% fruit infestation. In the present study, the combination of neem seed oil, and spray of Flonicamid resulted in a higher percentage reduction of the fruit infestation. Present findings are inconformity with those of Bagade *et al.* (2005) who reported that the test treatments resulted in a lower fruit infestation (8.05-14.38%) than the control treatment (25.03%) while using various botanicals concentrations along with the neem seed kernel extract and various conventional insecticides.

The maximum reduction in leafhopper population was recorded in block where flonicamid was applied alone (1.29 hoppers/leaf) and flonicamid and neem seed oil were applied in integration (1.86 hoppers/leaf)) at 5th observation followed by application of flonicamid and *C. carnae* (1.86 hoppers/leaf) and flonicamid and sanitation (1.99 hoppers/leaf). Application of neem oil and *C. carnae* alone demonstrated 4.16 hoppers/leaf and 4.15 hoppers/leaf, respectively. These findings can be compared with those of Sarode and Gabhane (1994) who also reported that the application of neem seed kernel extract and chemicals

Table 1.
Fruit infestation (Means±SE) recorded during different observations in various treatments.

Treatments	Predetermine Treatment Mean ±SE	1st observation Mean ±SE	2nd observation Mean ±SE	3rd observation Mean ±SE	4th Observation Mean ±SE	5th observation Mean ±SE	6th observation Mean ±SE
Control	27.77±0.75ab	27.61±1.55a	29.82±0.94a	32.58±0.60a	31.81±0.90a	32.89±0.87a	33.85±0.75a
Flonicamid @40g/Acre	27.13±0.86ab	17.00±0.60bc	14.39±0.30c	15.28±0.96d	16.03±0.62d	15.29±0.36d	15.81±0.40d
Sanitation at 15 days interval	28.19±0.76a	26.19±0.64a	30.75±0.94a	31.11±0.52a	30.43±1.25a	27.50±0.83b	26.19±1.19b
Crysoperlacarnae @1l/plant at week interval	26.64±0.91ab	19.78±1.84b	22.55±0.57b	25.24±0.49b	26.83±0.83b	25.15±0.83c	27.06±1.26b
Neem seed oil @ 5% at 15 days interval	27.40±1.28ab	19.81±0.98b	23.79±0.60b	20.53±0.72c	22.67±0.63c	21.16±0.97c	22.33±0.97c
Flonicamid and Sanitation	27.67±0.86ab	16.21±1.22cd	14.74±1.16c	14.46±0.56d	13.58±0.79e	16.69±0.84e	13.31±0.35e
Flubendiamide and Neem seed oil.	25.71±0.71b	13.11±0.86bc	14.14±0.29c	13.51±0.87d	12.95±0.19d	12.86±0.31e	14.52±0.50d
Flubendiamide and *Crysoperlacarnae*	26.74±1.17ab	16.51±0.44d	14.41±0.16c	15.28±0.42d	15.93.±0.60e	15.86±0.15f	15.99±0.31de
LSD at 0.05%	2.12	2.12	2.12	2.12	2.12	2.12	2.12
P- value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
F- value	31.8	2574	1620	2520	4378	4396	2197
df	$7_a/16_b$	$7_a/16_b$	$7_a/16_b$	$7_a/16_b$	$7_a/16_b$	$7_a/16_b$	$7_a/16_b$

Table 2.
Density of leafhopper (Means±SE) per leaf recorded during different observations in various treatments.

Treatments	Predetermine Treatment Mean ±SE	1st observation Mean ±SE	2nd observation Mean ±SE	3rd observation Mean ±SE	4th Observation Mean ±SE	5th observation Mean ±SE	6th observation Mean ±SE
Control	17.71±1.72ab	17.61±1.55a	19.82±0.94a	22.58±0.70a	21.81±0.90a	22.89±0.97a	23.85±0.85a
Flonicamid @40g/Acre	17.17±1.86ab	7.00±0.50bc	4.59±0.40c	3.18±0.86d	2.03±0.62d	1.29±0.46d	2.81±0.50d
Sanitation at 15 days interval	18.21±1.71a	13.19±0.54a	11.55±0.74a	9.01±0.62a	8.43±1.25a	6.50±0.93b	8.19±1.29b
Crysoperlacarnae @1l/plant at week interval	16.69±1.94ab	11.58±1.64b	9.75±0.67b	8.14±0.59b	7.83±0.83b	4.15±0.93c	5.06±1.36b
Neem seed oil @ 5% at 15 days interval	17.46±2.29ab	9.41±0.78b	8.99±0.70b	7.43±0.82c	6.67±0.63c	4.16±0.77c	5.33±0.87c
Flonicamid and Sanitation	17.68±1.88ab	6.11±1.12cd	4.94±1.06c	3.36±0.66d	2.58±0.79e	1.99±0.94e	2.31±0.65e
Flubendiamide and Neem seed oil.	15.75±1.73b	3.41±0.66bc	4.24±0.39c	3.41±0.97d	2.95±0.19d	1.26±0.71e	2.52±0.70d
Flubendiamide and *Crysoperlacarnae*	16.78±2.19ab	6.31±0.34d	4.51±0.13c	3.18±0.52d	2.93.±0.60e	1.86±0.55f	2.99±0.81de
LSD at 0.05%	2.42	2.42	2.42	2.42	2.42	2.42	2.42
P- value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
F- value	51.8	3551	912	1250	2548	1996	1877
df	$7_a/16_b$	$7_a/16_b$	$7_a/16_b$	$7_a/16_b$	$7_a/16_b$	$7_a/16_b$	$7_a/16_b$

application alone and in combination showed a significant control of okra leaf hopper than the untreated control. The present findings can partially be compared with those of Shukla *et al.* (1997) who applied different botanicals and endosulfan for the control of leafhopper and had a lowest damage with endosulfan followed by the other botanicals. Similarly, Gowri *et al.* (2002) observed that amongst various botanicals, Nimbecidine were found to be the most effective in controlling the Leafhopper as compared with the endosulfan. (2005sults revealed that all the treatments showed significantly minimum fruit infestation and reduction in leafhopper infestation as against the control. Maximum control was observed in those plots where neem seed oil and spray of Flonicamid were used in combination, followed by the integrated application of sanitation and spray of Flonicamid werech treatments resulted in 56.82% and 52.45% reduction in the fruit infestation, respectively. The present findings can partially be compared with those of Samuthiravelu Samuthvid (1991) as well as of Sarode and Gabhane (1994), who applied different botanical treatments along with different conventional insecticides for the control of leafhopper on okra and got variable results. In conclusion, application of flubendamide alone or in combination with neem-oil, sanitation and *C. carnea* proved better entities for the suppression of leafhoppers and reduction of fruit infestation.

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